CLAIMS

What is claimed is:

1. A motor control device for use in controlling an electric motor driven by a power generator that is adapted to output a square-wave voltage and a PWM-wave voltage in response to a switching control signal, comprising:

(a) a first input adapted to receive a signal indicative of a torque instruction value;

(b) a second input adapted to receive a signal indicative of the rotational speed of the electric motor; and

(c) a controller responsive to the first and second inputs and adapted to: determine the existence of a switching condition based on the first and second inputs; if a switching condition exists, generate a voltage control signal to lower the output voltage of the power generator; when the output voltage of the power generator is below a specified voltage level, generate the switching control signal to cause the power generator output to switch from the PWM-wave voltage output to the square-wave voltage output.

2. The motor control device of claim 1, wherein the controller is further adapted to gradually increase the duty ratio for the power generator's PWM-wave voltage output when a switching condition exists.

3. The motor control device of claim 1, wherein the controller is further adapted to generate the switching control signal to cause the power generator output to switch from the PWM-voltage output to the square-wave voltage output in response to the rotational speed of the motor exceeding a specified rotational speed.

4. The motor control device of claim 1, wherein the controller is further adapted to judge that the output voltage of the power generator is below a specified voltage level if a specified time period has elapsed.

5. The motor control device of claim 4, wherein the specified time period is based on a physical property of the power generator and a measure of the deviation between the specified voltage level and the output voltage of the power generator.

6. The motor control device of claim 5, wherein the physical property of the power generator is a time constant of a field magnet coil in the power generator.

7. A motor control device that controls an alternating current motor that drives the driving wheels of a vehicle based on a torque command value, comprising:

(a) a power generator driven by an internal combustion engine and adapted to supply power to the alternating current motor;

(b) a motor velocity sensing device that detects the rotational speed of the alternating current motor;

(c) an inverter that is disposed between the power generator and the alternating current motor;

(d) a square-wave voltage driver that controls the inverter to produce a square-wave voltage from the power generated by the power generator, and applies the square-wave voltage to the alternating current motor to put the alternating current motor in a square-wave voltage-driven state;

(e) a pulse-width-modulated wave driver that controls the inverter to produce a pulse-width-modulated wave voltage from the power generated by the power generator, and applies the pulse-width-modulated wave voltage to the alternating current motor to put the alternating current motor in a pulse-width-modulated wave voltage-driven state;

(f) a switching decision section that determines that the conditions for switching from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state have been met based on the rotational speed of the alternating current motor detected by the motor velocity sensing device;

(g) a voltage controller that decreases the voltage generated by the power generator when the switch controller has determined that the conditions for switching from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state have been met;

(h) a voltage sensor that detects that the voltage generated by the power generator has dropped below a specified voltage threshold value; and

(i) a square switching section to switch from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state when the switching decision section has determined that the conditions for switching from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state have been met, and when the voltage sensor has detected that the voltage generated by the power generator has dropped below the specified voltage threshold value.

8. The motor control device of Claim 7, further comprising:

a duty ratio changing module adapted to gradually increase the duty ratio of the pulse-width-modulated wave voltage when the switching decision section has determined that the

conditions for switching from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state have been met.

9. The motor control device of Claim 7, further comprising:

a forcible switching module that switches from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state when the motor velocity sensing device has detected that the rotational speed of the alternating current motor has exceeded a specified threshold value.

10. The motor control device of Claim 7, wherein the power generator has a magnetic field coil that is adapted for connection to a current source, and the voltage controller decreases the voltage generated by the power generator by decreasing the current supplied to the magnetic filed coil.

11. The motor control device of Claim 7, wherein the voltage sensor is a generated voltage sensing device that detects the voltage generated by the power generator.

12. The motor control device disclosed in Claim 7, further comprising a timer that measures the time elapsed from when the generated voltage is initially decreased by the voltage controller, and by the voltage sensor determines that the voltage generated by the power generator is below the specified voltage threshold value when the timer has detected that the specified time had elapsed.

13. A vehicle, comprising:

(a) an electric motor;

(b) power generator that is adapted to drive the electric motor with a square-wave output and a PWM-wave output in response to a switching control signal;

(c) a first input signal indicative of a torque instruction value;

(d) a second input signal indicative of the rotational speed of the electric motor; and

(e) a controller adapted to: determine the existence of a switching condition based on the first and second inputs; if a switching condition exists, lower the output voltage of the power generator; when the output voltage of the power generator is below a specified voltage level, generate the switching control signal to cause the power generator output to switch from the PWM-wave output to the square-wave output.

14. The vehicle of claim 13, wherein the controller is further adapted to gradually increase the duty ratio for power generator's PWM-wave voltage output when a switching condition exists.

15. The vehicle of claim 13, where in the controller is further adapted to generate the switching control signal to cause the power generator to switch from a PWM-voltage output to a square-wave voltage output when the rotational speed of the motor exceeds a specified rotational speed.

16. The vehicle of claim 13, wherein the controller is further adapted to determine that the output voltage of the power generator is below a specified voltage level if a specified time period has elapsed.

17. The vehicle of claim 16, wherein the specified time period is based on a time constant of a field magnet coil in the power generator and a measure of the deviation between the specified voltage level and the voltage level of the power generator output.

18. A motor control device that controls an alternating current motor that drives the driving wheels of the vehicle based on a torque command value, comprising:

(a) a power generating means for generating power to the alternating current motor;

(b) motor velocity sensing means for detecting the rotational speed of the alternating current motor;

(c) square-wave voltage driving means for producing square-wave voltage from the power generated by the power generating means and applying the square-wave voltage to the alternating current motor to put the alternating current motor in a square-wave voltage-driven state;

(d) pulse-width-modulated wave driving means for producing a pulse-width-modulated wave voltage from the power generated by the power generating means and applying the pulse-width-modulated wave voltage to the alternating current motor to put the alternating current motor in a pulse-width-modulated wave voltage-driven state;

(e) switching decision means for determining that the conditions for switching from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state have been met based on the rotational speed of the alternating current motor detected by the motor velocity sensing means;

(f) voltage decreasing means for decreasing the voltage generated by the power generating means when the switching decision means has determined that the conditions for switching from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state have been met;

(g) voltage decrease sensing means for detecting that the voltage generated by the power generating means has dropped below a specified voltage threshold value; and

(h) a square-wave switching means for switching from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state when switching decision means has determined that the conditions for switching from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state have been met, and when the voltage decrease sensing means has detected that the voltage generated by the power generating means has dropped below the specified voltage threshold value.

19. The motor control device of Claim 18, further comprising:

a duty ratio changing means for gradually increasing the duty ratio of the pulse-width-modulated wave voltage when the switching decision means has determined that the conditions for switching from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state have been met.

20. The motor control device of Claim 18, further comprising:

forcible switching means for switching from the pulse-width modulated wave voltage-driven state to the square-wave voltage-driven state when the motor velocity sensing means has detected that the rotational speed of the alternating current motor have exceeded a specified threshold value.

21. The motor control device of Claim 18, wherein the power generator has a magnetic field coil that is adapted for connection to a current source, and the voltage decreasing means decreases the voltage generated by the power generating means by decreasing the current supplied to the magnetic field coil.

22. The motor control device disclosed in Claim 18, wherein the voltage decrease sensing means is a generated voltage sensing device that detects the voltage generated by the power generating means.

23. The motor control device disclosed in Claim 18, further comprising a timer means for measuring the time elapsed from when the generated voltage is initially decreased by the voltage decreasing means, and by the voltage decrease sensing means determines that the voltage generated by the power generating means is below the specified voltage threshold value when the timer means has detected that the specified time had elapsed.

24. A method for controlling an electric motor driven by a power generator that is adapted to output a square-wave voltage and a PWM wave voltage, comprising:

(a) determining whether a switching condition exists based on the rotation speed of the electric motor and a torque instruction value;

(b) lowering the voltage output of the power generator if a switching condition exists; and

(c) switching the output of the power generator from PWM-wave voltage to square-wave voltage if a switching condition exists and the output of the power generator is below a specified level.

25. The method of claim 24, further comprising:

gradually increasing the duty ratio for the PWM-wave voltage output when a switching condition exists.

26. The method of claim 24, further comprising:

switching the output of the power generator from the PWM-wave voltage output to the square-wave voltage output when the rotation speed of the electric motor exceeds a specified rotation speed.

27. The method of claim 24, further comprising:

determining that output of the power generator is below a specified level once a specified time period has elapsed, wherein the specified time period is based on a time constant of a field magnet coil in the power generator and a measure of the deviation between the specified voltage level and the voltage level of the power generator output.